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Room temperature controls:

How the EU is missing an opportunity for substantial energy savings

Executive summary

The lack of incentives and regulation to drive the uptake of room temperature controls in homes is the single biggest missed opportunity to improve the energy efficiency of EU homes.

In particular, we should be taking the simple step to ensure that all radiators (the most common form of heating in homes) are fitted with at least a Thermostatic Radiator Valve (TRV) rather than a manual valve. Therefore TRVs should be a minimum standard in residential, non-residential, old and new buildings.

Thermostatic Radiator Valves are a cost-effective energy saving technology that reduce wasted heating in homes, leading to fuel cost savings of up to 30% or even higher. They are also necessary to ensure that the energy savings predicted when insulation is added or a heating boiler is upgraded actually materialise in practice. In addition, they provide greater comfort and therefore an improved indoor environment quality for the occupants. It should also be noted that TRVs do not need a power supply and have a long lifetime.

Current estimates, by eu.bac and others, show that there are around 70 million homes in the EU (41% of those that have radiators) that still only have manual radiator valves (MRVs) on their radiators. This effectively means that around 500 million radiators need to be upgraded from MRVs to TRVs. In addition there are nearly 250 million with TRVs older than 20 years old that could be economically upgraded.

If all of these radiators were upgraded, the annual EU energy saving would be 160 TWh, saving 29 million tonnes of CO_2 and nearly €12 billion from the energy bills of EU citizens. These upgrades would pay back in 2 years with an overall return on investment of €7 for every €1 spent.

Thermostatic Radiator Valves are a proven technology that are readily available, with a well-established supply chain. Yet there is a clear market failure given that a significant number of radiators still only have a Manual Radiator Valve.

To harness the potential savings, the European Union needs to make sure that there is a regulatory framework to drive the uptake of TRVs, particularly for new buildings and for existing buildings at times when the heating system is being refurbished, and incentives where regulation is not appropriate. The review of the Energy Performance of Buildings Directive and the forthcoming Preparatory Study on the ecodesign of Building Automation and Controls are perfect opportunities in which to establish how this is best achieved.

Why focus on heating systems to reduce residential energy use?

Heating is the most significant energy use in residential buildings, accounting for between 48% and 69% of the total home energy use in 24 of the EU28 countries[1].

Two thirds of EU homes are heated with a 'wet' central heating system that comprises a centralised boiler circulating heated water to radiators in each room. The preparatory study for the ecodesign of space heaters in 2007 concluded that the carbon emissions from gas and oil central heating boilers in Europe were of the same magnitude as that from all road transport[2].

The ecodesign and energy labelling of space heaters mainly tackles the thermal efficiency of the boiler. To reduce the energy used for heating homes it is also necessary to have individual room temperature controls; something that is currently neglected from a policy perspective.

How room temperature controls save energy

When a designer plans a heating system they will make sure that each room has a radiator big enough to heat that room when the outside temperature is at its coldest. Consequently, although the heating system is used for up to eight months of the year, there will only be a few days when the outside temperature is cold enough that each radiator needs to be fully on, otherwise they are producing excess heat which results in wasted energy. This is why you need room temperature controls.

A heating boiler will usually be fitted with a central temperature control to make sure it runs efficiently. This avoids waste when the boiler converts gas or oil into heat, but it is still possible for the boiler to run efficiently while at the same time producing more heat than is needed.

Temperature controls in individual rooms prevent this. They make sure that the boiler only produces enough heat to automatically keep rooms at a comfortable temperature and no more. This means that the heating system is both efficient and economical.

Why insulation savings depend on the presence of individual room temperature controls.

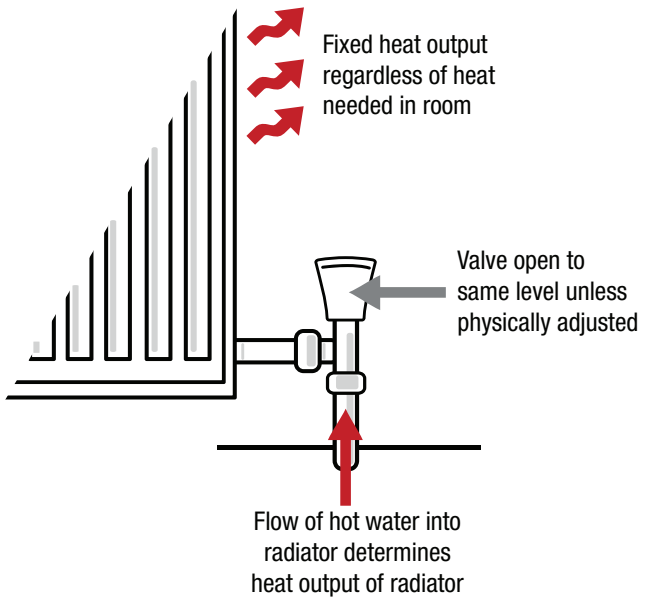
Predicted energy savings from insulation assume that the temperature inside the building is the same before and after the insulation is installed. In practice this will only happen if there are room temperature controls to stop overheating. Some studies have shown occupants with insulation fitted complaining that the house became too warm and they had to open windows to keep it cool[3].

[1] http://www.entranze.enerdata.eu/#/share-of-space-heating-in-total-residential-consumption.html
[2] Eco-design Boilers, Executive Summary, 30 Sept. 2007, VHK for European Commission
[3] Domestic energy use study: to understand why comparable households use different amounts of energy, Brook Lyndhurst for the Department of Energy and Climate Change, 2012

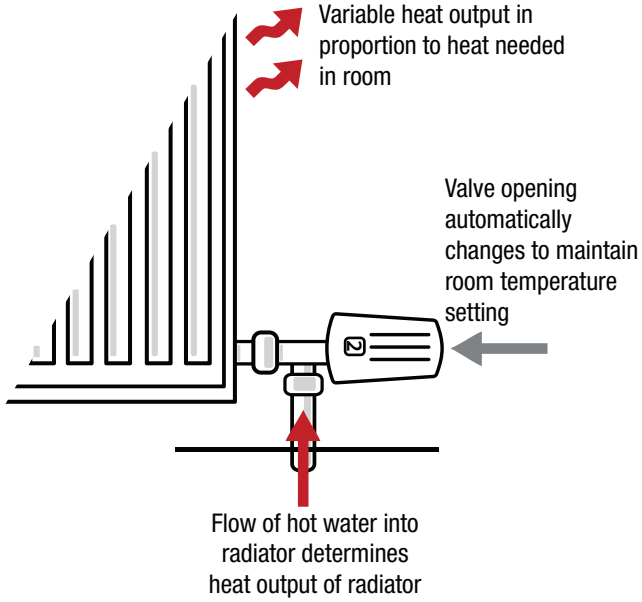
What is a Thermostatic Radiator Valve?

Thermostatic radiator valves (TRVs) are by far the most common form of room temperature control. They are fitted to a radiator where it connects to the pipework, replacing the manual valve that would be used to set up the system. They independently monitor the temperature of the room they are in and automatically adjust the heat output of the radiator in response to this so that a comfortable temperature is maintained (see diagrams below).

Manual Radiator Valve



Thermostatic Radiator Valve



How TRVs work:

- The valve will automatically open to allow the radiator to get the room up to temperature, and then close down just enough for the radiator to maintain this temperature.
- The boiler will sense when the TRVs are closing and either turn off or reduce the amount of heat it produces in response to this.
- The less heating needed in the room then the more the TRVs will close and the less heat the boiler will produce.
- The TRVs will also reduce the heat output of a radiator if the room is getting a lot of sunshine, or if additional heat is generated by people or electrical appliances in the room. This will lead to further energy savings.
- If the TRV temperature setting is reduced (for example in an unoccupied room) then the heat output will be further reduced to only maintain this lower temperature.

What are the energy savings from TRVs?

There are many studies confirming that the installation of TRVs in a home delivers a reduction in energy use. Indeed, it should be noted that, from an engineering perspective, TRVs are a well- established technology whose prime function is to reduce waste heat.

A 2016 study by the University of Salford in the UK compared the operation of a real, full-sized heating system with and without TRVs. The system was set up so that it maintained comfortable room temperatures without any room temperature controls at a typical outside design temperature of -4%C. This meant that the heating system was balanced to the design heat load (which in theory all systems should be.) The outside temperature was then progressively increased and the system energy use measured, both with and without TRVs installed, so that the amount of wasted energy from overheating without TRVs could be measured. The energy savings from TRVs were as below:

Outside temperature	Energy saving from using TRVs
-4ºC	Baseline
5ºC	14%
7ºC	19%
9ºC	18%
12ºC	28%
15ºC	41%

This work was carried out in conjunction with BRE who manage the energy performance calculation methodology for buildings on behalf of UK Government, with the data to be used to update information in this calculation methodology.

These savings represent a thorough independent test process and are consistent with other studies that have been done across Europe. For example:

- The European Standard covering the impact of control types[4] assesses that changing from a simple Manual Radiator Valve (MRV) to a TRV equals a 20% saving in heating energy (and that upgrading a TRV more than 20 years old equals a 7% saving in heating energy.)
- IMI Hydronic commissioned a study from TU Dresden to assess the potential savings from TRVs based on a computer simulation. This produced a range of figures showing savings of 8 – 28% depending on the energy efficiency of the building, type of boiler and whether it is a high or low temperature heating system.
- Simulation work done for the manufacturer Danfoss[5] assessed that savings of approximately 36% were possible for the installation of TRVs in individual dwellings.

On the basis of these studies we estimate that **a widespread replacement of Manual Radiator Valves with Thermostatic Radiator Valves would deliver an overall heating energy saving of 18%.**

Potential EU energy savings from TRVs

We carried out a detailed analysis of European data and statistics to calculate the overall potential energy savings if all radiators that currently only have Manual Radiator Valves were upgraded to Thermostatic Radiator Valves. This has been done on a country by country basis so that calculations for each country are also available. The spreadsheet showing the calculations and detailing all of the data sources can be viewed on the eu.bac website[6].

The first part of the spreadsheet covers household and heating system data from sources such as Eurostat and the ENTRANZE project to establish how many dwellings in the EU have a boiler and radiators to provide their heating. Added to this is data for the number of homes that currently have TRVs, and the energy savings potential for those without TRVs as referenced above. Data from the European Environment Agency on average annual energy used for heating homes in each country then allows the total potential savings to be calculated as both energy, carbon dioxide and as a cost saving using the Eurostat gas prices for individual member states. Some work has also been carried out by eu.bac to get TRV installation costs from actual installers in different countries. The addition of this data allows us to calculate the simple payback and return on investment of these upgrades being carried out.

The analysis shows that around 70 million homes in the EU (41% of those that have radiators) still only have manual radiator valves (MRVs) on their radiators, which means around 500 million radiators have the potential to be upgraded. The potential for EU homes is as below:

EU homes could save 130 TWh of energy per year by installing TRVs on radiators that don't have them. Also upgrading TRVs over 20 years old would increase this to 160 TWh.

This would reduce EU CO_2 emissions by 29 million tonnes.

EU citizens would save nearly €12 billion per year on their energy bills.

The cost of these upgrades would be paid back in energy savings in 2 years.

For every €1 spent there would be over €7 in savings.

[4] EN 15316-4-2:2008 Heating systems in buildings. Method for calculation of system efficiencies.
[5] Energy efficiency related to the change of thermostatic radiator valves – Prof. Dr.-Ing. Hirschberg (2016)
[6] www.eubac.org

Additional savings potential

There are also a significant number of radiators with TRVs that are more than 20 years old, which can be economically refurbished to more modern technology making additional savings in homes (a further 30TWh per year as noted above).

These savings only look at residential buildings but there are many non-residential buildings that also have radiators and where there will be the potential for energy savings from installing TRVs. These are not included in the above figures.

Proposed policy changes to achieve the energy savings

To harness these savings, the European Union needs to make sure that the installation of TRVs as a minimum standard is mandated or directed. Article 8 of Directive 2010/31/EU on Energy Performance of Buildings already requires EU Member States to ensure optimisation of energy performance of heating systems in existing buildings but there is far too little progress[7]. Within the proposal to amend this Directive, released as part of the 2016 Clean Energy Package, this could be done with the addition of a paragraph in Article 8 that requires Member States to ensure that newly built and existing residential buildings are equipped with individual room temperature controls.

Such clarity is needed within the text of the Directive itself, to demonstrate that this is an essential element of the existing provisions of Article 8.

At the very least, specific guidance should be provided to Member States for their building codes to ensure that compliance with the EPBD includes requirements for individual room temperature controls to be fitted in new buildings, and when heating systems are installed or upgraded (including when the boiler is replaced) in both residential and non-residential buildings. Such an approach would address continuing missed opportunities to install TRVs. It would also demonstrate that TRVs are an important energy saving measure and thereby encourage Member States to launch wider regulation or incentives for existing buildings.

The forthcoming preparatory study on the eco-design of Building Automation and Controls is the perfect opportunity in which to establish how this is best achieved.

Why regulation is needed

The fact that there are currently 500 million radiators in the EU that still have manual radiator valves demonstrates that there is a market failure, and that the current legislative framework is ineffective. TRVs have been on the market for over 40 years, a period during which almost all homes will have had a new heating system installed or the boiler replaced. It is clear that many heating systems have been installed or modernised without TRVs being installed. The reason for this is that many people tend to focus on the short term cost rather than the long term running costs, particularly given that many boiler replacements can be a distressed purchase. Regulation is needed to ensure that the small additional cost of room temperature controls is seen as necessary for the long term interests of the consumer and the environment.

There has been regulation in Germany since the early 1970s to require all radiators to have TRVs. As a consequence 95% of homes in Germany have TRVs compared to the EU average of 59%.

In the UK, the Government decided in 2006 to downgrade the building regulations requirement for TRVs to be installed when a boiler is replaced from a minimum standard to only 'good practice' on the basis that most customers would choose to have them installed anyway. Three years later annual sales of TRVs had declined by nearly 30% even though boiler sales had increased by 7%.

The lack of consistent and comprehensive energy performance standards for heating systems across the EU mean that in some member States it is still permissible for manual radiator valves (MRVs) to be installed in new buildings today. This, simply put, is an unacceptable situation when buildings are supposed to have high standards of energy performance.

[7] http://www.ecofys.com/en/publications/optimising-the-energy-use-of-technical-building-systems/ (2017)

A 'no regrets' policy approach

We are confident that a policy approach driving the application of individual room temperature controls would be a 'no regrets option for the European Commission for the following reasons

1. The weight of evidence indicates that the **expected saving in heating energy use** across EU homes would be **18%** where manual radiator valves are converted to TRVs.

2. The total estimated annual saving by 2030 is **160 TWh** and **29 Mt CO_2**. This is with a return on investment for the EU of €7 for every €1 spent.

3. These estimated savings are of the same order as those calculated in a separate report by Ecofys in 2016[8] which used a different approach and methodology but came to very similar conclusions. **This clearly indicates that we can have a good level of confidence in the scale of opportunity.**

4. For individual households evidence shows that **savings** can be as much as **30-38%** on their heating bills depending on their current heating system characteristics and behaviour. The **payback** on installing room temperature controls is calculated as **1-3 years.**

5. In multifamily buildings with central heating systems individual room temperature controls enable citizens to take responsive action to heat metering/cost allocation and billing information, thus **supporting the requirements of the Energy Efficiency Directive.**

6. There is **no 'lock in'** to the widespread application of TRVs on radiators as a minimum standard. The highest cost comes with the initial draining of the heating system to replace the valve, after which the control head can be easily upgraded at a later date should new or 'smart' technology become readily available.

7. The concept of upgrading energy efficiency of buildings through a 'fabric first' approach should not be used to push heating controls down the list. Because room temperature controls automatically maintain room temperatures **they will prevent any additional overheating that might occur when a building is insulated.** The expected savings from insulation are predicated on the assumption that room temperatures are the same before and after the insulation is installed – in fact it is only with room temperature controls in place that you can guarantee this will be the case.

[8] This study calculates the savings effects for reference cases (buildings and heating systems) in 11 EU countries and extrapolates the results for the whole EU residential building stock.

About eu.bac

eu.bac is the European Building Automation and Controls Association. We represent 28 European manufacturers of products for home and building automation. This corresponds to an annual market of approximately 4,4€ billion. With this economic potential, we are Europe's largest platform dedicated to energy efficiency in buildings.

Our Vision

"A world where energy efficiency and sustainability in every building is achieved through the optimal application of home and building controls, automation systems and services."

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